Hands-On TAROT: Intercontinental use of the TAROT for Education and Public Outreach

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Abstract.

The TAROT telescope has for primary goal the search for the prompt optical counterpart of Cosmic Gamma-Ray Bursts. It is a completely autonomous 25cm telescope installed near Nice (France), able to point any location of the sky within 1-2 seconds. The control, scheduling, and data processing activities are completely automated, so the instrument is completely autonomous. In addition to its un-manned modes, we added recently the possibility to remotely control the telescope, as a request of the "Hands-On Universe" (HOU) program for exchange of time within automatic telescopes for the education and public outreach. To this purpose we developed a simple control interface. A webcam was installed to visualize the telescope. Access to the data is possible through a web interface. The images can be processed by the HOU software, a program specially suited for use within the classroom. We experienced these feature during the open days of the University of California Berkeley and the Astronomy Festival of Fleurance (France). We plan a regular use for an astronomy course of the Museum of Tokyo, as well as for French schools. Not only does Hands-On TAROT gives the general public an access to professional astronomy, but it is also a more general tool to demonstrate the use of a complex automated system, the techniques of data processing and automation. Last but not least, through the use of telescopes located in many countries over the globe, a form of powerful and genuine cooper-

ation between teachers and children from various countries is promoted, with a clear educational goal.

1. Introduction

They have been several attempts of using astronomical data in the classroom, in general within the framework of physics, mathematics, and/or astronomy courses. Using directly a telescope in the college backyard has many advantages, mainly that children themselves practice astronomy with a telescope. However, several problems may arise:

- Except for the Sun, astronomical observations take place at night, making them somewhat difficult to accommodate on a regular basis, both for pupils and teachers.
- Many schools are located in town, and do not have any dark area where to locate a telescope at night.
- Teachers are typically not experienced astronomers.
- Having a telescope in the school requires some care in handling and maintaining it.
- Not all colleges can afford a telescope with (or even without) a CCD camera.

To that purpose, the Hand-On Universe program (Pennypaker et al. 1998; Boër et al. 2001) has been initiated to use astronomical data within the classroom. Telescope time is exchanged within the HOU network, in order to enable the use various telescopes over the world. Most of them may be remotely controlled, allowing to use them at night.

2. TAROT, an autonomous observatory

The prime objective of the *Télescope à Action Rapide pour les Objets Transitoires* (TAROT; Boër et al., 1999; Boër et al. 2000; http://tarot.cesr.fr), is the real time observation of cosmic Gamma-Ray Bursts (hereafter GRBs). TAROT is a 25cm telescope, with a full autonomous control system, and able to point any location over the sky within 1-2 seconds. Figure 1 displays the functional diagram of TAROT. In normal operations, the *MAJORDOME* (Bringer et al., 2000) computes the schedule and sends observation requests to the *Telescope Control System*, which takes care of the various housekeeping, points the telescope, and activates the CCD Camera. As soon as the data is taken, it is pre-processed, with dark, bias and flat-field substraction, cosmic ray removal, astrometric reduction, and a source list is built. The requests for observations are now sent via the web. Should a GRB alert occurs (from the HETE-2 satellite), the present observation is interrupted, and the telescope slews immediately to the position of the GRB source.

The interfaces with the users, beside the "alert" connection with the GCN, are as follows:

- The main interface has now been rewritten as a web form. The user is requested to write the coordinate of the source, the number (up to

6), duration and filter(s) (6 positions) of the frames he/she wants. A unique identifier is attributed to the request as soon as the user validates it. The new request is taken into account by the *MAJORDOME* software at the next start of the scheduling process, at least once a day or whenever some event interrupts the operation at night, e.g. rain. Since the form is available through the web, the user can use any computer system.

- As a request of the HOU program, we included a direct remote interface, written in the Java language, again to avoid any preference to a particular operating system. The user can operate directly the telescope, provided the *MAJORDOME* accepts input from this interface. Any kind of image can be acquired from this interface. However, one of the telescope operators has to log in the system to allow operations through this interface.

3. Discussion

We tested the various TAROT user interfaces at several public demonstrations. They proved to be very reliable. During the day, the presence of a webcam enables the user to see the immediate reaction of an instrument located at several hundreds or thousands kilometers from him. At night, images are available through the web within one or two minutes, on a page which includes the image in jpeg, and the fits header. Optionally, the sources from the USNO A2.0 catalog can be superimposed on the image (Thiébaut and Boër, 2001), an asteroid chart can be requested, and the DSS can be extracted using a preformatted SKYVIEW query.

Since the prime goal of TAROT is doing science, we still prefer that users from schools either use frames from the scientific program (including frames acquired during the last night), or send requests to the batch interface, reserving the direct remote interface for demonstration purposes during the day or at night. We plan also to enhance this interface par allowing the *MAJORDOME* to schedule in advance the blocks of nights allowed for a use in direct access mode.

We found also that what seems evident to the astronomer, has to be explained to general audiences, e.g. phenomena like saturation of frames, angles expressed in hours, and that a telescope located in the northern hemisphere has some difficulties to look at e.g. the Magellanic Clouds (this has also to be explained to several astronomers), or that the accessible sources in the sky varies from winter to summer. To cope with these last points, we plan to have a more interactive and pedagogical interface. In any case, this exercise of porting a system devoted to a somewhat specialized audience to the general public proved to be a very interesting and rewarding adventure for the TAROT team.

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http://arXiv.org/ps/astro-ph/0109371v1